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READING RAILRAOD.

Much has been said, written and published in relation to this railroad, and its managers. Bold predictions have been made in relation to its durability under the trade which it is destined to bear; and as to its ability to compete successfully with the canal for the coal trade. From some cause, to a stranger wholly inexplicable, there exists in the minds of many of the wealthy citizens and business men of Philadelphia, a strong prejudice and opposition to the work. If doubts of its success, or predictions of its failure, or even curses loud and long could have suspended its progress, it would now be numbered among the things that were; and notwithstanding the great benefits which it has already conferred, and will hereafter confer, on the *coal consuming* community, there are thousands who would rejoice to have it prove a total failure. It is to be hoped, however, and it is confidently believed by those who look at it with a favorable eye, that its success is certain.

This work was projected and commenced during a period of great prosperity—but like many others, it was overtaken, before completion, by a general depression of trade and unparalleled derangement of the financial affairs of the country; and, but for the most determined perseverance and energy of its friends, it would probably have been suspended before it reached the coal region, thereby rendering the part completed in a great degree valueless. This, to many, desirable result, was avoided, and by great effort the road was opened to the coal region in 1842, in which year 49,000 tons and in 1843 230,000 tons of coal, besides other freight, passed over it. This year the coal tonnage will not fall much if any, short of 450,000 tons, which will make the aggregate of tonnage over the road since its completion about equal to 1,000,000 upon the single track mainly. In consequence of having but one track completed it has been necessary to keep up a higher rate of speed, with the coal trains, tran is considered proper, which has been to some extent injurious to the rails; yet, on an examination such as

we were able to give, at the various stopping places in passing twice over it, we are of the opinion that most of the rails now in use on the first track will sustain a further tonnage two or three times greater than has already passed over them. The second track, more than half of which is completed and the remainder in a state of forwardness, which with six new locomotives of great power, and a large number of new iron cars of improved construction, will enable the company to increase their business largely this fall, and to be in readiness on the commencement of business next year to work at much greater advantage and economy than they have hitherto done.

The new track is laid with a rail of 60 lbs. to the yard, and of much better form than that first laid down, having at least double the thickness or amount of metal, in the *tread*, thus giving it greater strength and durability.

The new cars are of iron throughout, and of capacity to contain *five* tons instead of $3\frac{1}{3}$—the capacity of the wooden cars—and of superior form and construction, having springs at the connection, thereby relieving them to a considerable extent from the effects of the shock in starting the train, which is very severe when the train consists of *one hundred* cars with 375 to 400 tons of coal, which is now a common load for the new engines.

The company have now a good supply of locomotives of various kinds, many of which have been considered of great power; one made by Messrs. Baldwin, Vail and Hufty, took a train of 100 cars, or a gross load of 481 tons in February 1841, and another the "Monocacy," from the New Castle Manufacturing Co., took 100 cars with 335 tons of *coal* at a load. These and others in use on the road, have been considered superior engines —but those recently put on, the "United States," the "New England," the "New York" and the "Ontario," from the manufactory of Messrs. Baldwin and Whitney, surpass any, it is believed, that have heretofore been constructed in this, or any other country. They are called 16 ton engines, but are somewhat heavier, and are on six wheels, 46 inches diameter, all connected as drivers and all in front of the fire box. Cylinders 15 inches diameter, and 18 inch stroke. The boiler has 137 tubes 12 feet long, $1\frac{3}{4}$ inch diameter. The calculated maximum load 750 tons—which one of these, the United States, has performed repeatedly, it is said, during the months of July and August; and with such ease that it is estimated that she will haul on a level 1000 tons, gross.

The company are also extending their wharves and depot at Richmond, on the Delaware, so as to accommodate a large business. Last year and the early part of this, they could accommodate and load at the same time, from 15 to 20 vessels, and by the opening of next season they will be able to load 30 to 35 at the same time; which, with the completion of a new branch road, from Mount Carbon, ten or twelve miles up the valley of the Schuylkill and a connection with the Little Schuylkill railroad at Port Clinton, by which a large additional trade, now given entirely to the canal, for want of connection with the railroad, will ensure a vast increase of bu-

siness next year. Indeed they are now, in their unfinished condition, with but a track and a half, short of cars and locomotive power, performing more labor than *any other railroad* in the world! They are at this time hauling over 190,000 tons, *one mile daily.* Where is the other road doing as much? In a few weeks it will be increased to 250,000 tons; and next season to a much larger amount, and at rates much lower than have ever been known before; thus reducing the cost of fuel to a large section of country on the sea board, and along the navigable rivers and canals, to an amount not less than one and a half or two millions of dollars a year—which, in five or six years, would reimburse its entire cost—and contributing to the comfort and necessities of millions of people, and yet we find a greater hostility existing against it in its vicinity than to any other work in the country—to be accounted for, probably, on the same ground that the introduction of *improved machinery* is often resisted in the manufacturing districts, by the operatives—but in this case as in those, experience is sure to effect a change of feeling in the public mind; and the Reading railroad is destined to become one of the most successful enterprizes of the age.

BALTIMORE AND SUSQUEHANNA RAILROAD.

The enterprizing citizens of Baltimore, in their efforts to secure their full share of the western trade, have accomplished more in the way of *roads* and *railroads* than any other equal amount of population in this country except Boston. Before the era of canals and railroads, their turnpikes were at least equal, if not superior, both in extent and character, to those emanating from any other city of equal population in the Union: and when New York had completed her great canal, and Pennsylvania had commenced her improvements, Maryland, or rather *Baltimore*, dashed boldly into the then almost untried railroad system, and commenced two distinct lines, the Baltimore and Susquehanna and the Baltimore and Ohio railroads, for the accommodation of the western trade. From thus dividing her forces many difficulties have arisen, and, although much has been accomplished, the great object in view, viz. to reach the waters of the Ohio river, has not yet been attained; of course all the advantages anticipated from the outlay of so much capital have not been realized.

The route adopted by the Baltimore and Susquehanna railroad company had many obstacles to be surmounted, including two summits besides much of the way laying through deep ravines, requiring many sharp curves and a greater number of bridges, we believe, than on any other road in the country, there being over 80 bridges in 57 miles, to York. It was undoubtedly the intention of this company to turn in a westerly direction after crossing the Pennsylvania line and thus reach Pittsburgh by a continuous railroad; but not being able to accomplish that desirable object they directed their course towards Columbia, on the Susquehanna, where they connect with the Pennsylvania works—the canals westward and Columbia and Philadelphia railroad eastward and thus open an easy and pleasant communica-

tion between Philadelphia and Baltimore; and although the distance by this route is somewhat greater between the two cities than by that through Delaware, yet to those who travel to enjoy delightful scenery we would heartily recommend the route, by York, Columbia and Lancaster either going or coming, and thus enjoy the pleasure of passing through some of the most highly cultivated regions and beautiful farms of Pennsylvania, and at the same time through some of the wildest and most picturesque valleys in Maryland. Leaving Baltimore at 9 o'clock A.M. the cars arrive at Philadelphia at about 7 P.M. Fare, $3,50 through.

When in Baltimore a few weeks since, we were, through the politeness of the president of the company, invited to accompany the directors over the road to York and Columbia, which enabled us to form some opinion of the extent of their operations, their system of police and the character of their engines, cars, etc.

On leaving the office in North street, the cars are moved by horse power for more than a mile, until they arrive at the main depot and machine shop, quite out of the city. Here an exchange of horses is made and one of *iron* taken. The locomotives of this company are of an efficient class; taking heavy loads over their 80 feet grades, with great ease; but of these we hope to be able to speak more definitely hereafter. Their cars are of a superior description. The passenger cars have one safeguard quite new to us and which we would earnestly recommend to other companies, and especially to those who use the flat bar rail. They have put an *under floor* of inch oak boards to all their passenger cars, which will prevent accidents from "*snake heads*," from which some sad ones have occurred in this country. The cost is but trifling, yet the security afforded to the passengers, we are induced to believe from our own observation, is sufficient to render its adoption *imperative* on every flat bar road in the country.

The freight cars in general use on this road are superior, in many respects, to any we have seen, that is, they carry a greater amount of freight in proportion to the weight of the car, than on most roads. They have six wheels, the body is made light but strong, resting on *wood* springs, consisting of two pieces each 2 inches by six, and 13 feet long, of white ash plank. Other companies will do well to examine them and either adopt, or improve upon them. The success of railroads will depend much on the introduction of improvements in the various details in their management; and in no one particular is greater economy to be introduced, perhaps, than in the weight and construction of cars; many of those now in use are altogether too heavy in proportion to their capacity, especially on the Pennsylvania roads where the State furnishes roads and motive power and the forwarders own the cars or *section boats*, in which about *two* tons of freight are carried for *three* tons of dead weight, or car!

The charge for freight on merchandize, produce, etc., on this road is, from Baltimore to Columbia, 75 miles, $1 12½ per 1000 lbs., and on plaster 80 cents. The police of the road appears to be excellent. We have a

copy of the regulations before us which appear to be well arranged to insure safety, if followed, and the best evidence that they are attended to, in our opinion is, that very few accidents have, as we are informed, occurred on the road.

PAPERS ON PRACTICAL ENGINEERING: NO. 2.

A special report on the Sea Wall, built in the year 1843, *for the preservation of Ram Head at the northwest end of Lovell's Island, in the harbor of Boston, Mass., by* Col. S. Thayer, *U. S. corps of Engineers.*

We are indebted to a friend for a copy of No. 2, of these most welcome and unexpected papers. The great variety of work executed under the superintendence of the U. S. engineers, the scientific acquirements of the corps and the circumstance of their having leisure to investigate and calmly note down the numerous details of construction so interesting to the profession, lead us to anticipate much good from the publication of these papers. Our readers are acquainted with the papers published by the Royal engineers to which, as well as to the Transactions of the Institution of Civil Engineers, their costly mode of publication is a most serious objection. The present number is by an officer as well known as he is highly esteemed.

By an act of congress, passed March 3d, 1843, the sum of $16,000 was appropriated for a "sea wall on Lovell's island, Boston harbor." The part of the island intended to be secured is called Ram Head, a small remnant of one (the northwestern) of the two eminences originally forming the island, or rather, probably separate islands, until in process of time, the water course between them became filled up by the debris proceeding from the destruction of the former. These debris, consisting mostly of very coarse gravel and pebblestone, have moreover been driven southerly in the direction of Gallop's island, and pushed far into the main channel, leaving the present width of the channel at this place about two hundred yards. These changes, viz: the abrasion of the island, and consequent invasion of the channel, have been steadily advancing up to the present time, and so rapidly of late years, as to render it almost certain, that the latter would be closed at no distant period, unless the evil could be arrested by the preservation of Ram Head. Such was the origin and object of the work about to be described.

The topography of the site, and the position, form and dimensions of the sea wall, generally, are exhibited in the sheets of drawings herewith submitted. The levels are referred to the plane of (extreme) low water, corresponding to that of the map of George's island, executed by Col. Kearny.

The beach, to the distance of several hundred feet, and in some directions to a much greater distance from the wall, is a little above the level of half tide; varying from seven to ten feet above the plane of reference. It consists of pebbles embedded in hard clay, and is protected from further abrasion by the large stones (boulders) covering its surface, probably remaining near where they fell from the bank as it receded, being too massive to be swept away by the sea. This beach may therefore be considered as *permanent.*

Above the foundation, which consists entirely of beton, the wall is faced up to the coping with blocks of granite in regular courses of about two feet each in thickness or rise. Every course consists of headers or stretchers placed alternately, their dimensions being as follows, viz:

Headers.—None less than four feet, or over five feet long, average about 4′ 8″; least width two feet, average width 2′ 3″; the widths being measured on the narrowest heads, which are always in the face of the wall.

Stretchers.—Length.—None less than six feet; average length about eight feet. *Width.*—No bed less than two feet.

The stretchers are so jointed, as to be three inches longer on the back than in front, thereby forming a dovetail joint with the headers. These last, being widest in rear, are thus also kept in place by the backing of the wall, which is composed wholly of beton. Thus all the materials of the wall are inseparably connected by a system of dovetailing.

The entire beds and joints are hammered full, and laid in contact, stone to stone, the cement mortar in which they are laid only filling the small cavities between the *touching points.*

Headers, two feet in thickness, in part five feet, and in part 4′ 3″ long, and averaging 3′ 9″ in width, constitute the coping course.

The number of stones in the wall (headers, stretchers, quoins and caps inclusive) is 903, amounting, when hammered, to 901·85 cubic yards, or to a cubic yard each on a general average.

The width of the wall at the upper surface (on which the coping rests) is 5′ 6″, and the average width, including the foundation, is about six feet.

There are in the foundation 540·5 cubic yards, and in the backing of the superstructure 795·7 cubic yards, altogether 1336·2 cubic yards of beton, which added to the granite facing and coping above stated, make the contents of the wall 2238·07 cubic yards.

Cost of Masonry.

Stone in the rough,	$4097·21 ÷ 901·86 =		$4·54307
Mortar materials,	175·26	"	0·19433
Dressing,	2585·08	"	2·86639
Laying,	567·74	"	0·62952
Machines and tools,	404·09	"	0·44806
Receiving and hauling materials,	338·02	"	0·37480
Total cost per cubic yard,			$9·05617

Foundation Beton.

Mortar, 8·17 cub. ft.	Cement, 256·37 pounds = 3· cub. ft. stiff paste,		$1·2820
	Sand, 674 pounds = 8·2 cub. ft. loose = 6·75 cub. ft. perfectly compact,		0·1715
Gravel, 25·13 cub. ft.,			0·2397
Making mortar,	0·0647 days		
Mixing beton,	0·1090 "	0·2595 days	
Transporting do.	0·0545 "		0·3056
Packing do.	0·0313 "		
Tools, implements, platforms, runs, hauling sand, etc., etc.,			0·1121
Total cost per cubic yard,			$2·1109

Backing Beton.

9 cub. ft.	Cement, 281½ pounds = 3·28 cub. ft. stiff paste,		$1·4065
	Sand, 741 lbs. damp = 9 cu. ft. loose = 7·2 cu. ft. compact,		0·1892
Gravel, 24·1 cubic feet,			0·2298
Making mortar,	0·0648 days		
Mixing beton,	0·1214 "	0·3178 days	
Transporting do.	0·0555 "		0·3753
Packing do.	0·0761 "		
Tools, implements, platforms, etc.,			0·1121
Total cost per cubic yard,			$2·3129

Average cost of the whole beton (foundation and backing),

$2981·35 ÷ 1336·2 = $2·2312.

Entire Cost of Masonry.

Stone work,	901·86	*at*	$9·05617	$8167·40
Beton,	1336·21	*at*	2·3129	2981·35
Total,	2238·07	*at*	4·9814	$11148·75

A batch of mortar was composed as follows:

Cement = 1 cask 321¼ pounds (average) = 3·75 cubic feet stiff paste.

Sand = two wheelbarrow boxes heaped = 856⅔ pounds damp from heap = 10¼ cubic feet loose = 8½ cubic feet reduced to minimum bulk.

This dose of sand was about 50 per cent. greater than would have been used in mortar for ordinary masonry, or for beton in caps or arches. The result of the mixture was 10¼ cubic feet of stiff mortar = 11 cubic feet in a limber state, such as when used. There were made in all 1128 batches = 1128 × 10¼ = 11562 cubic feet = 428·22 cubic yards, costing as follows:

Cement = 362·400 pounds *at* ½ cent, - - -	1812·00
Sand = 476·92 tons *at* 51 cents nearly, - - -	243·24
Labor, including transport of mortar to beton bed, average distance 40 yards = 86·5 days., - - - - -	102·33
	$2157·57

Cost of cubic yard of Mortar.

Cement = 846·06 pounds = 9·9 cubic ft. stiff paste, -	4·231
Sand = 1·11373 tons = 27 cubic ft. loose = 22¾ cubic ft. perfectly compact, - - - - - - -	0·568
Labor = 0·2019 days, - - - - - - -	0·239
27 cubic feet *at* 18¾ cents, - - - -	$5·038

The mortar was made by hand, in a box 7′ long, 5′ wide, and 11½″ deep, which had been constructed for a different purpose, but answered sufficiently well for this. One half of the sand was first put in and spread, then a cask of cement, and over this the remainder of the sand. The water (salt) was then added, and the mixture effected in the usual way by two men, to whom a third man was occasionally added.

The batch of mortar above described = 10¼ cubic feet was mixed, for foundation beton, with eight barrows full of shingle = 31½ cubic feet and for backing beton, with 7 barrows full = 27½ cubic feet. With respect to the latter, however, it is to be remarked that the whole of the mortar was not mixed with the shingle, a certain portion, say about six per cent., being applied to the surfaces in contact with the beton in the wall. The shingle was of every size from that of a pea to pebbles of 6 inches diameter, and the different sizes so proportioned as to give a minimum void. Although this void was not accurately ascertained, yet, judging from experiments with other materials not dissimilar, and from the bulk produced by the mixture of given quantities of the shingle and mortar, I feel safe in stating it at somewhere between 20 and 25 per cent. of the volume of the shingle.

The process of fabrication was briefly as follows:

The shingle having been brought in wheelbarrows from the pile or depot near by, and spread on the platform (formed of rough boards) in a layer from 8 to 12 inches in thickness, (according as the materials are more or less coarse) the finest shingle at bottom, and all the pebbles at top, the batch of mortar is spread over it as evenly as possible. The mixture is effected by four men, viz: two with shovels and two with hoes, the former facing each other, and each commencing at a corner of one of the sides of the pile, work from the exterior towards each other, until they meet, throwing

each shovel full so as to form an irregular ridge, the commencement of a new pile, at a convenient distance on one side. They then step back and recommence a new section (the width of the shovel) and operate in the same manner depositing this portion by the side of the other, until the whole mass is turned and formed with the aid of the hoes into a heap similar to the original. As each shovel full is turned up and spread, or rather scattered by a jerking motion, it is seized by the hoe and brought into proper form and position being thereby more intimately mixed. The heap is again turned in like manner, but in the opposite direction, when the mixture is complete, all the surfaces of the shingle being well covered with mortar.

It is scarcely necessary to observe, that the success of the operation depends entirely on the proper management of the tools, which, although not a difficult act, is seldom attained without the particular attention of the overseer. The ordinary gang, exclusive of mortar makers, was as follows:

For foundation Beton.

4 men bringing shingle and mixing.

2 men transporting beton, (each filling his own barrow) and mixing.

1 man at trench, levelling and ramming, to whom two others were occasionally added, in which case four men were kept constantly at the shovel and hoe, turning and mixing.

For Backing Beton.

2 men bringing shingle and mixing.

2 men wheeling beton and mixing.

2 men at the wall, one plastering the surface in contact with the beton, the other arranging the beton and ramming.

Each course of facing stones was backed up as fast as laid, the back of the beton being sustained by moveable boxings, each consisting of a couple of 2″ planks about 20 feet in length, fastened together, edge to edge, with battens, and kept in place by *plank* or *joist* braces in rear. These boxings could be safely removed in several hours after the beton was packed.

ANOTHER RAILROAD ROUTE BETWEEN NEW YORK & BOSTON.

We have received a circular signed by the principal citizens of Middletown Con., in which they call the attention of the inhabitants along the line to the project of a railroad through Middletown to Norwich, and thence to Providence and Boston. They say that "at the last session of the legislature of the State of Connecticut, a charter was granted for a railroad in continuation of the Hartford and New Haven railroad, to the line of New York State, in order to perfect a continuous road from Boston to New York city, at all seasons of the year.

"Another charter was also granted, to connect the city of Middletown with the Hartford and New Haven railroad; and it is now proposed to continue this road from Middletown, east to Providence and Boston via Norwich, by occupying a part of the Norwich and Worcester road to the most convenient point diverging therefrom to the Providence and Stonington road; or by such other route as upon examination shall prove most practicable. This project, if carried out, will place Providence, Norwich, Middletown and the intermediate towns, forever on the great mail route from Boston to New York city."

Of the advantage and convenience to the people on the proposed line we have not a doubt. The following comparative statement of distances between it and the Springfield route shows a saving of 19 miles.

New Haven to Boston by proposed route.		New Haven to Boston, via Springfield, Ms.	
New Haven to Wallingford,	10 miles.	New Haven to Hartford,	37 miles.
Wallingford to Middletown,	13 "	Hartford to Springfield,	26 "
Middletown to Norwich,	32 "	Springfield to Worcester,	59 "
Norwich to Plainfield,	15 "	Worcester to Boston,	45 "
Plainfield to Stonington, R. I.,	24 "	Total,	167 "
Thence to Providence,	13 "		148 "
Providence to Boston,	41 "	Difference in favor of proposed route,	19 "
Total,	148 "		

Total extent of new road to be constructed on proposed route, 69 miles.

ON THE MENSURATION OF EXCAVATION AND EMBANKMENT UPON CANALS, ROADS, AND RAILROADS: BY ELWOOD MORRIS, CIVIL ENGINEER.

On directing the attention to public works, one is immediately struck with the vastness of the amount of money expended in excavation, embankment and masonry: forming on the roads and railroads, usually the chief, and on the canals nearly the only items of outlay. We have the authority of the Chev. de Gerstner, that the 3000 miles of railway this year in operation in the United States, cost sixty millions of dollars.* Of which, perhaps, forty millions were laid out in graduation and masonry alone.

When to this, we add the immense expenditures for similar objects upon the canals and roads of the Union, will it be too much to say that near one hundred millions of dollars have been disbursed in the earthworks, requisite to reduce the routes to proper levels, and the architectural constructions necessary to pass the streams.

This large amount of work having been done chiefly by contract, and paid for by the cubic yard, or perch, the vast importance of accuracy and uniformity in calculating the contents of excavation, embankment and masonry solids, must be palpable to all. Unfortunately, great diversity has existed, and still continues to exist, in the modes of mensuration adopted by engineers; they may, however, in a general way, be divided into two principal methods, and the modifications which flow from them; first, those which depend on *arithmetical* and second, those dependant on *geometrical*, average.

When we state that neither of these modes is exact, except in a limited number of cases, we merely mention what is well known to every engineer: but which is a reason not the less powerful, to induce us to seek more perfect methods.

The importance of this subject will, we trust, be a sufficient apology for laying before the readers of the Journal of the Franklin Institute a few observations, with the hope of drawing to it the attention of abler minds.†

We are aware, that it is urged by some, that the modes of measurement are immaterial, provided, the values of the unit of measure computed in a particular mode were known, and that mode generally adopted; and this argument would have great force if any single rule or method of mensuration was used in general practice. But while on some works the mode of computation uniformly errs in excess, on others it probably errs in deficiency, or, otherwise, according to circumstances; and this brings us back to the importance of a uniform and more exact mode.

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* See Journal Franklin Institute for September, 1839.

† A treatise on the mensuration of excavation and embankment, from the pen of a northern engineer, well able to manage such a subject, was lately announced as being in the press, it has not however (the writer believes) yet been published.

The work here referred to by Mr. Morris, is that of E. F. JOHNSON, Esq., C. E., which our readers will recollect, was published at our office in 1840. ED. R. R. J.

The surface of the ground is regarded by the engineer, as being composed of planes, variously disposed with relation to each other; so that any vertical section, will exhibit a rectilineal figure more or less regular. This supposition, though not strictly correct, is sufficiently accurate for practical purposes, and avoids any necessity of entering into the complex calculations pertaining to warped surfaces.

The usual method of measuring excavation and embankment, is by taking vertical sections, perpendicular to the centre line of the canal or road, and at short distances apart, in which the elevation or depression of numerous points in the ground, above or below the bottom of canal or grade of road, is ascertained by the spirit level and rod, while their distances out, right and left, are measured (generally) with a tape line.

These elevations or depressions are commonly called *plus* or *minus cuttings*, or simply *cuttings*, and the distances of the several points from the centre line are denominated shortly *distances out.* The *cuttings* then are ordinates or perpendiculars drawn from the plane of grade or bottom, to intersect the surface of the ground; and the *distances out*, are the horizontal distances of those perpendiculars from the centre line, (measured at right angles) or the abscissa of those ordinates, which, by deduction, give the distances apart of the separate cuttings.

The details of the operation of *taking the cuttings* require great nicety, but are so well known to practical engineers as to render unnecessary a description at length. We may, however, mention a general rule which must not be neglected if accurate results are desired; viz. *At every change of slope transversely, single cuttings and distances out, must be taken, and at every longitudinal change, sections of cuttings.*

Upon rough ground it is customary to make the lateral distances apart of the cuttings uniformly ten feet, which materially facilitates the subsequent calculations. We may here observe that the cuttings and distances out, are commonly taken in feet and tenths, and the regular stations of one hundred feet, are divided by cross sections (or sections of cuttings) into shorter lengths if the ground requires, as it almost always does.

Some engineers have suggested the division, and we believe some have had their rods and tapes divided, into yards and decimals; and some retaining the rod and tape as usual, have made their regular stations fifty-four feet, and have spaced their cross sections where they required to be nearer, so that their distances apart should be some aliquot part of 54 feet. These methods, though they somewhat expedite the office work where the quantities are ascertained by the process of arithmetical average, are not, however, generally adopted by the profession. A foot being usually the unit of lineal measure, a hundred feet a regular station, and the cubic yard the unit of the solidity of excavations and embankments.

The isometrical diagram, fig. 1, plate 1, represents a regular station of embankment on irregular ground, with an intermediate cross section at 50 feet or midway. Base or width of road surface = 30 feet, slopes 2 to 1, *a*, *b*, *c*, *d*, *e*, *f* and *g*, are cuttings, *minus cuttings*, in this case. 1: 2: and 3: are the *sections of cuttings*, or cross sections. C, C, is the centre line.

Earth work on roads and canals is usually laid off in divisions called *sections* of half a mile or more in length, and when a sufficient number of transverse sections of the ground have been obtained, or technically when the "*cuttings are taken*," the transverse profiles or cross sections are drawn upon paper, their areas calculated, and the solid contents of the excavations and embankments computed; generally by one of two rules, viz:

No. 1: *By arithmetical average.*—Multiply the sum of the end areas by their distance apart, and divide the product by 6 and by 9; the result will give, *approximately*, the number of cubic yards in the given length of excavation or emoankment.

No. 2: *By geometrical average.*—Multiply the sum of the end areas, and the square root of their product, by the distance apart, and divide the product by 9 and by 9. The result will be, *nearly*, the number of cubic yards in the given length of excavation or embankment.

All the dimensions in both cases being in feet and decimals.

Of these rules, No. 1, gives a result always in excess, except when the excavation or embankment solid, happens to be a prism or cylinder, or when the sums of the right and left distances out, are the same for both the end areas used.

And, No. 2, though accurate when applied to prisms, cylinders, pyramids and cones, or their frustra, fails on application to the prismoid or wedge as well as to embankment or excavation solids, on irregular ground, where the difference is great between the areas of adjacent transverse sections.

Such is a brief sketch of the modes in common use for measuring excavation and embankment on roads and canals; of which we may observe, that the method, (No. 1,) and all others founded upon the same principles, necessarily lead to errors, often of magnitude, and particularly in deducing "deficient embankment," as is very well shown by Mr. Macneill, in the introduction to his excavation and embankment tables published in 1833. It is true, that engineers in this country would seldom fail to arrive at much closer results than Mr. Macneill has instanced; because, being well aware, that this very convenient rule (No. 1,) always gives results which are in excess in some ratio to the difference of any two areas averaged, they take care to place their cross sections so near together that this difference may be small, and consequently by closely pursuing this course are enabled to reach results proportionally more exact. Indeed, the writer has often known sections of cuttings on sidehill, to be taken but 10 feet apart longitudinally, and in some extraordinary cases among rocks even at a less distance.

The rule No. 2, though not liable to so many, nor such strong objections, is still obnoxious to some: and where greater, indeed almost precise, accuracy is attainable without much more labor, we cannot but think it highly desirable, and accordingly propose to develope a method much superior, as it appears to us. But before doing so, the writer distinctly disclaims any attempt at novelty, as to the principles employed; for they have been long known to those versed in mensuration, and have also been applied to the matter in hand by the eminent engineer before alluded to (J. Macneill, Esq., C. E., etc.,) in his publication in 1833. It is believed, however, that as a *general process*, the mode about to be laid down has not yet been used on any work.

Upon the general supposition that any given length of excavation or embankment is a solid bounded laterally by plane surfaces, and terminated at both ends by transverse sections, or planes, perpendicular to the centre or guiding line of the excavation or embankment; the contents of that solid may be accurately computed by aid of the "prismoidal formula," used by Mr. Macneill, who gives a very good demonstration of it as applied directly to one of the solids under consideration. Mr. Macneill's tables, though carefully made out, and undoubtedly useful in a level country, are unfortunately not of very ready application to common cases, owing to the variable transverse figure of the ground not having been (and which indeed is

scarcely capable of being) taken into the account in the tabular arrangement employed by that distinguished practical writer.

The "Prismoidal Formula" referred to, is as follows:

Parallel sections each perpendicular to the guiding line of the excavation or embankment.

Let b = the area of the base, or of a cross section at one end of a given length of excavation or embankment.

" t = the area of the top, or other end section.

" m = the area of a section midway between the two, and deduced from them.

" h = the height of the solid, or perpendicular distance between the end sections.

" S = the solidity.

Then the general formula $= \overline{b + 4m + t} \times \frac{1}{6}h = S.$

This is the rule for the capacity of a prismoid, demonstrated in almost every treatise on mensuration. And it is also *the general formula* for the mensuration of all solids, whose bases and tops, or edges, lie in parallel planes, and whose sides are bounded either by planes or right lines; and from it can be directly deduced the common rules for the solidity of prisms, etc., as will be shown hereafter.

* It applies to a prism or cylinder as a prismoid, (so to speak) of which the two end sections are equal: to a cone or pyramid as a similar solid, one of whose end sections is nothing; and for the same reason it is applicable to the wedge. As the full demonstration of this remarkable property would occupy much space, we prefer the inverse method of deducing from the general formula, the common rules for the solidity of prisms, pyramids, etc., the truth of which have been already proven by the writers on mensuration; this will be a proof of the general rule, perhaps quite as satisfactory to the reader, and will, at least, have the recommendation of brevity.

General formula $= \overline{b + 4m + t} \times \frac{1}{6}h = S.$

1. *Prisms or Cylinders.* *

Here $b = m$, or $4m = 4b$, and $t = b$, substituting these values, general formula becomes $\overline{b + 4b + b} \times \frac{1}{6}h = S$, or $6b \times \frac{1}{6}h = S$, or finally $b \times h = S$, which is the common rule, usually expressed thus,

"Multiply the area of the base by the height of the prism, and the product will give the solid content."

By figures referring to the diagram, fig. 2, plate 1.

By General Formula.	By Common Rule.
$10 \times 8 = 80 = b$	$10 \times 8 = 80 = b$
$10 \times 8 \times 4 = 320 = 4m$	$48 = h$
$10 \times 8 = 80 = t$	$b \times h = \overline{3840} = S.$
$\overline{480}$	
$8 = \frac{1}{6}h$	
$\overline{3840} = S.$	

2. *Pyramids and Cones.*

Here $t = o$, $m = \frac{1}{4}b$, or $4m = b$, substituting these values the general formula becomes $\overline{b + b + o} \times \frac{1}{6}h = S$, or $2b \times \frac{1}{6}h = S$, or finally $b \times \frac{1}{3}h = S$, which is the common rule usually stated in words thus,

* This subject is noticed by (I believe) Sir George Head, in a work on England, speaking of a system of education.

"Multiply the area of the base by one third of the height, and the product will be the solid content."

By figures referring to the diagram, fig. 3, plate 1.

By General Formula.	By Common Rule.
$10 \times 8 = 80 = b$	$10 \times 8 = 80 = b$
$5 \times 4 \times 4 = 80 = 4m$	$16 = \frac{1}{5}h$
$0 \times 0 = 0 = t$	$1280 = S.$
160	
$8 = \frac{1}{6}h$	
$1280 = S.$	

3. *The Wedge.*

Here let e = length of the edge, l = length of the back, and d = depth or thickness of the back.

Then in the general formula, $t = o$. $b = l \times d$, $m = \frac{l+e}{2} \times \frac{d}{2}$ or $4m = \overline{l+e} \times d$, substituting these values, general formula becomes $\overline{l \times d + \overline{l+e} \times d} \times \frac{1}{6}h = S$, or $\overline{l \times d + l \times d + e \times d} \times \frac{1}{6}h = S$, or finally $\overline{2l+e} \times d \times \frac{1}{6}h = S$, which is the common rule usually expressed thus,

"To the length of the edge, add twice the length of the back; multiply this sum by the breadth (or thickness) of the back, and then by one sixth of the height of the wedge; the product will be the solid content."

By figures see the diagram, fig. 4, plate 1.

By General Formula.	By Common Rule.
$10 \times 8 = 80 = b$	$10 \times 2 + 30 = 50 = 2l + e$
$20 \times 4 \times 4 = 320 = 4m$	$8 = d$
$0 \times 30 = 0 = t$	400
400	$8 = \frac{1}{6}h$
$8 = \frac{1}{6}h$	$3200 = S.$
$3200 = S.$	

To the frustra of either of the above solids, the general formula is equally applicable, to prove which we observe, that the frustrum of a prism is still a prism, and the frustrum of a wedge is a prismoid; it only remains then to show the application to

4. *The Frustrum of a Pyramid.*

Here, for the sake of simplifying the demonstration, suppose the frustrum to be of a pyramid having a square for its base. Let a = a side of the base of the frustrum, and c = a side of the top. Then in the general formula $b = a^2$ $t = c^2$ and $m = \frac{a+c}{2} \times \frac{a+c}{2}$ or $m = \frac{\overline{a+c}^2}{4}$ hence $4m = \overline{a+c}^2 = a^2 + 2ac + c^2$. Substituting these values the general formula becomes $\overline{a^2 + a^2 + 2ac + c^2 + c^2} \times \frac{1}{6}h = S$, or $\overline{2a^2 + 2ac + 2c^2} \times \frac{1}{6}h = S$, or $\overline{a^2 + ac + c^2} \times \frac{1}{3}h = S$.

But $ac = \sqrt{a^2 \times c^2}$ substituting which the formula becomes $\overline{a^2 + \sqrt{a^2 \times c^2} + c^2} \times \frac{1}{3}h = S$, which is the common rule usually expressed thus,

"The sum of the areas of the ends and the square root of their product,

multiplied by one third of the height (or perpendicular distance between the ends) gives the solidity of the frustrum."

What is true of frustra of pyramids is also true of those of cones, though owing to the properties of the circle, the rule for the solidity of conic frustra is generally differently stated: it will be observed that the common rule above deduced for pyramidal frustra is identical with rule No. 2, sometimes used to find the contents of excavations and embankments.

By figures see the diagram, fig. 5, plate 1.

By General Formula.	By Common Rule.
$20 \times 20 = 400 = b$	$20 \times 20 = 400 = a^2$
$16 \times 16 \times 4 = 1024 = 4m$	$\sqrt{400 \times 144} = 240 = \sqrt{a^2 \times c^2}$
$12 \times 12 = 144 = t$	$12 \times 12 = 144 = c^2$
1568	784
$8 = \frac{1}{6}h$	$16 = \frac{1}{3}h$
$12544 = S.$	$12544 = S.$

Now there is no excavation or embankment solid such as we have supposed, that cannot be divided into prisms, prismoids, pyramids, or wedges, or some combination of them, having a common length or height, equal to the distance between the end areas or cross sections. And the height or length being common to all, it will be evident on reflection, that if a given portion of excavation or embankment be composed of any number of the solids named, the area of one end section will equal the sum of the areas of the bases or tops of those solids, the other end area the sum of their tops or bases, and the area of the mid-section will equal the sum of the areas of their middle sections; and, hence, if (as has been proved) the capacities of the separate solids are reducible to one general rule, the solidity of a whole body composed of such solids, and having the height as one common dimension, may therefore be computed by the same rule.

The general process, then, the adoption of which we suggest as a valuable succedaneum to those in common use, will be to compute by the general formula from the sections usually taken in the field, in the following manner: draw the sections in a book, leaving between each two space enough for the middle section, which will be subsequently deduced from those drawn; on each left hand page should be placed either three sections, (including the mid-section) or some multiple of three, depending on the character of the ground, and the size of the leaf; the right hand page being left open to record the calculation upon. The scale we would recommend to be twenty feet to the inch.

To prevent misapprehension, we will here observe, that in speaking of excavation or embankment, the centre line is always supposed to be a tangent, that being the universal presumption, in practical calculations; altho' upon curves, owing to the convergence of the cross sections, (they being taken on the radii,) this hypothesis is not exact, and consequently occasions some error, not often, however, of much importance, though cases will sometimes arise (where the primary angle of deflection is unusually large) that ought to receive correction for curvature.

Though not absolutely indispensable, it will be found convenient in using the prismoidal method of calculation, as well as conducive both to expedition and accuracy, to observe the following rules in "*taking the cuttings*," as far as the character of the surface may admit, viz:

1. On sidehill, at each section of cuttings where the work runs partly in

filling, and partly in cutting, ascertain the point where grade or bottom strikes ground surface.

2. On every transverse section take a cutting at both edges of the road, or, at the distance out right and left of one half the base.

3. Always take a cross section, whenever either edge of the road or base passes from excavation to embankment or vice versa.

4. On sidehill, if the ground admits, take the cuttings (not otherwise provided for) uniformly at ten feet apart.

5. Wherever the ground admits, so place the cross section as to be at some decimal division of 100 feet apart, as 10, 20, etc.

Excavation and embankment solids naturally divide themselves into three classes or cases, with modifications, and under one or another of these cases or their modifications, will fall nearly every kind of ground; though on a very intricate surface, such as a rocky hillside, cases may arise, requiring additive or deductive solids, but the engineer will find little difficulty in managing such, without violating, or interfering with, the general process.

Case 1. *Prisms.*

Embankment or excavation, either on level ground, or on ground inclined transversely, and level longitudinally, at the same distance out.

Modification 1: all excavation, or all embankment. *Modification* 2: both filling and cutting.

Case 2. *Prisms, Prismoids and Pyramids.*

Embankment or excavation, on ground inclined longitudinally in one plane, and level transversely.

Modification 1: all excavation, or all embankment. *Modification* 2: passage from excavation to embankment, or the reverse.

The above two cases do not often exist in practice, that following being of the most general occurrence.

Case 3. *Prisms, Prismoids, Pyramids and Wedges, or a combination of them.*

Excavation or embankment on ground inclined *both* longitudinally and transversely.

Modification 1: all excavation, or all embankment. *Modification* 2: cutting and filling both. *Modification* 3: passage from cutting and filling to either cutting or filling. *Modification* 4: complete passage from excavation to embankment on sidelong ground.

The general formula admits of a modification, more convenient for use in computing excavation and embankment. It is as follows:

$\frac{b+4m+t}{6}\times h=S$, in lieu of $\overline{b+4m+t}\times\frac{1}{6}h=S$; this modification we shall employ; and now proceed to give examples in figures of each case, but it may be as well previously, to make some remarks relative to deducing the middle section between any two which have been taken in the field and sketched in the section book.

To average for the cuttings of the middle section, commence either at centre or at grade, if there be a grade point upon the cross section, and having regard to the inclination of the ground, proceed each way, averaging the cuttings as they occur, for a corresponding cutting of the middle section, and their distances out, or rather their distances apart, for a corresponding distance apart; and if there be more cuttings in one section than in the other, the surplus cuttings (of the same kind) on each side, all average with the *outer* cutting on that side, and their distances apart divided by

two (or averaged with 0,) give the corresponding distances of the cuttings which answer to them upon the mid-section. But the averages may be made in any other way demanded by the transverse slopes of the surface, provided all the cuttings are used, and that lines drawn to join any two cuttings averaged, do neither meet between the end sections nor cross. In the mid-section will always appear the same number of cuttings as are contained in that end section which has the most; and its correctness admits of verification thus,

1. ½ sum of distances between the extreme cuttings of the end sections equals the distance between the extreme cuttings of the mid-section. This proves it horizontally: to verify it vertically,

2. Where the number of cuttings of both kinds is the same in each end section, ½ sum of all the cuttings of the end sections, equals the sum of all the cuttings of the middle section.

3. Where the number of cuttings in the end sections is different, to prove the cuttings of excavation, ½ sum of the cuttings of the end sections, equals the sum of the cuttings of the mid-section; *minus*, least outer cutting left of centre multiplied by ½ the difference in the number of cuttings in the end sections on the left; *plus*, least outer cutting right of centre multiplied by the difference in the number of cuttings on the right.

Though this last rule is long in words, it is short in practice, and of course only refers to the excavation or plus cuttings in proving excavation, while the same process applied to the minus cuttings will verify the embankment of the middle section.

The exemplifications which will be given apply to the graduation of a road, or railroad, but the principles apply equally to a canal, as the tow path and berm banks above bottom are constant quantities.

In all the following examples the slopes are considered to be the same on both sides of the centre, which is supposed to divide equally the surface of grade, or the base as it will be called. The sections numbered 1: and 3: will uniformly be presumed to be those taken in the field, while No. 2: will represent the middle section deduced from the end sections, 1: and 3: the distance between which, will, for convenience, be assumed at 30 feet in every case. Excavations, as to figure, are merely embankments inverted, and hence, as a matter of course, the same principles apply to both.

In all the examples, the results obtained by rules No. 1 and 2, will also be set down for the sake of exhibiting how great in some cases the differences are: the base will be assumed at 30 feet, the slopes at 2 to 1, and C, C, will represent the centre line of the road.

Example of Case 1: *Modification* 1: *fig.* 6, *plate* I.

$h = 30.$

	Multipliers.	Areas.	Cubic yds.
1.	$\frac{30+54}{2} \times 6$	= 252	
2.	$\frac{30+54}{2} \times 6 \times 4$ . . .	= 1008	
3.	$\frac{30+54}{2} \times 6$	= 252	
		6)1512	
		30 × 252	= 280
	By rule No. 1		= 280
	By rule No. 2		= 280

Embankment.

	Multipliers.		Areas.	Cub. yds.
1.	15×4	=	60	
2.	$15 \times 4 \times 4$	=	240	
3.	15×4	=	60	
			6)360	
		$30 \times$	60	= 66⅔
	By rule No. 1			= 66⅔
	By rule No. 2			= 66⅔

Excavation.

Multipliers.		Areas.	Cub. yds.
15×2	=	30	
$15 \times 2 \times 4$	=	120	
15×2	=	30	
		6)180	
	$30 \times$	30	= 33⅓
By rule No. 1			= 33⅓
By rule No. 2			= 33⅔

Example of Case 2: *Modification* 1: *fig.* 8, *plate* I.

Multipliers.		Areas.	Cub. yds.
1. $\frac{30+54}{2} \times 6$	=	252	
2. $\frac{30+46}{2} \times 4 \times 4$	=	608	
3. $\frac{30+38}{2} \times 2$	=	68	
		6)928	
	$30 \times$	154⅔	= 171·8
By rule No. 1			= 177·8
By rule No. 2			= 167·0

Example of Case 2: *Modification* 2: *fig.* 9, *plate* II.

Multipliers.		Areas.	Cub. yds.
$\frac{30+62}{2} \times 8$	=	368	
$\frac{30+46}{2} \times 4 \times 4$	=	608	
0×15	=	0	
		6)976	
	$30 \times$	162⅔	= 180·7
By rule No. 1			= 204·4
By rule No. 2			= 136·3

Example of Case 3: *Modification* 1: *fig.* 10, *plate* II.

	Multipliers.		Areas.	Cubic yds.
	Add	$37 \times 14 = 518$		
		$11 \times 10 = 110$		
1.		$18 \times 5 = 90$		
		$13 \times 6 = 78$		
		$\overline{796}$		
	Deduct	$\overline{16}^2 + \overline{4}^2 = 272$		
		$\overline{524}$	= 524	
	Add	$17{\cdot}5 \times 10{\cdot}5 = 183{\cdot}75$		
		$15{\cdot} \times 28{\cdot}5 = 427{\cdot}50$		
2.		$23{\cdot} \times 6{\cdot} = 138{\cdot}$		
		$19{\cdot} \times 5{\cdot}5 = 104{\cdot}50$		
		$7{\cdot} \times 14{\cdot} = 98{\cdot}$		
		$\overline{951{\cdot}75}$		
	Deduct	$\overline{18}^2 + \overline{5}^2 = 349{\cdot}$		
	Multiplied by 4,		$\overline{602{\cdot}75}$	= 2411
	Add	$19 \times 21 = 399{\cdot}$		
		$16 \times 20 = 320{\cdot}$		
3.		$12 \times 14 = 168{\cdot}$		
		$10 \times 12 = 120{\cdot}$		
		$8 \times 15 = 120{\cdot}$		
		$\overline{1127{\cdot}}$		
	Deduct	$\overline{20}^2 + \overline{6}^2 = 436{\cdot}$		
		$\overline{691}$	= 691	
			6)3626	
			$30 \times$ 604⅓	= 671·5
		By rule No. 1		= 675·0
		By rule No. 2		= 672·9

Example of Case 3: *Modification* 2: *fig.* 11, *plate* III.

Excavation. — Multipliers.		Areas.	Embankment. — Multipliers.		Areas.
	5 × 1 = 5			16 × 7 = 112	
1.	4 × 10 = 40			6 × 5 = 30	
	8 × 25 = 200			142	
	245			Deduct $\overline{8}^2$ = 64	
	Deduct $\overline{10}^2$ = 100			78	= 78
	145	= 145		11·5 × 5·5 = 63·25	
	4·5 × 1·5 = 6·75			12·5 × 4· = 50·	
	5· × 7· = 35·			10·5 × 3· = 31·5	
2.	10·5 × 17·5 = 183·75			7·5 × 3· = 22·5	
	13·5 × 11· = 148·5			14· × 6· = 84·	
	374·			8·5 × 2·5 = 21·25	
	Deduct $\overline{13}^2$ = 169·			372·5	
	4 × 205	= 820		Deduct $\overline{11}^2$ = 121·	
	4 × 2 = 8			4 × 151·5	= 606
	4 × 6 = 24			15 × 11 = 165	
3.	13 × 10 = 130			17 × 8 = 136	
	17 × 22 = 374			13 × 6 = 78	
	536			7 × 6 = 42	
	Deduct $\overline{16}^2$ = 256			12 × 5 = 60	
	280	= 280		7 × 2 = 14	
		6)1245		495	
	Mean area =	207·5		Deduct $\overline{14}^2$ = 196	
				299	= 299
					6)983
				Mean area =	$163\frac{5}{6}$

Excavation.	Cub. yds.	Embankment.	Cub. yds.
Mean area,	207·5 × 30 = 230·6	Mean area,	$163\frac{5}{6} \times 30$ = 182·
By rule No. 1,	= 236·1	By rule No. 1,	= 209·4
By rule No. 2,	= 232·0	By rule No. 2,	= 196·6

Example of Case 3: *Modification* 3: *fig.* 12, *plate* IV.

Embankment. — Multipliers.		Areas.	Excavation. — Multipliers.		Areas.
	15 × 31 = 465				
	12 × 10 = 120				
1.	11 × 10 = 110			Excavation =	0
	9 × 4 = 36				
	6 × 6 = 36				
	2 × 5 = 10				
	777				
	Deduct $\overline{18}^2$ = 324				
	453	= 453			
	5·5 × 12·5 = 193·75				
	11· × 5· = 55·				
2.	10·5 × 5· = 52·5			5· × 1· = 5·	
	9·5 × 2· = 19·			3· × 4· = 12·	
	7· × 13· = 91·			5·5 × 3· = 16·5	
	5· × 2·5 = 12·5			10·5 × 10·5 = 110·25	
	423·75			12· × 10· = 120·	
	Deduct $\overline{14}^2$ = 196·			263·75	
	4 × 227·75 =	911		Deduct $\overline{10}^2$ = 100·	
	Carried forward	1364		4 × 163·75 =	655
				Carried forward	655

	Brought forward	1364		Brought forward	655
3.	$8\times20=160$			$5\times4=20$	
	$3\times5=15$			$6\times8=48$	
	175			$11\times6=66$	
	Deduct $\overline{10}^2=100$			$21\times21=441$	
	75	= 75		$24\times20=480$	
				1055	
				Deduct $\overline{20}^2=400$	
				655	= 655
		6)1439			6)1310
	Mean area =	$239\frac{5}{6}$		Mean area =	$218\frac{1}{3}$

Embankment.	Cub. yds.	Excavation.	Cub. yds.
Mean area,	$239\frac{5}{6}\times30=266\cdot5$	Mean area,	$218\frac{1}{3}\times30=242\cdot6$
By rule No. 1,	$=293\cdot3$	By rule No. 1,	$=364\cdot$
By rule No. 2,	$=263\cdot8$	By rule No. 2,	$=242\cdot6$

Example of Case 3: *Modification* 4: *fig.* 13, *plate* III

Excavation.—Multipliers.		Areas.	Embankment.—Multipliers.		Areas.
			$11\cdot5\times10=115\cdot$		
			$10\cdot5\times10=105\cdot$		
			$9\cdot\times4=36\cdot$		
1.	Excavation =	0	$7\cdot5\times10=75\cdot$		
			$6\cdot5\times5=32\cdot5$		
			$6\cdot\times5=30\cdot$		
			$5\cdot\times5=25\cdot$		
			$5\cdot\times2=10\cdot$		
			428·5		
			Deduct $\overline{12}^2=144\cdot$		
			284·5	=	284·5
	$2\cdot5\times1\cdot=2\cdot5$		$11\cdot5\times2\cdot5=28\cdot75$		
	$3\cdot5\times2\cdot5=8\cdot75$		$10\cdot5\times2\cdot5=26\cdot25$		
2.	$5\cdot5\times2\cdot5=13\cdot75$		$9\cdot\times1\cdot=9\cdot$		
	$9\cdot\times5\cdot=45\cdot$		$7\cdot5\times2\cdot5=18\cdot75$		
	$12\cdot\times2\cdot5=30\cdot$		$6\cdot5\times1\cdot25=8\cdot125$		
	$10\cdot5\times18\cdot=189\cdot$		$3\cdot\times2\cdot5=7\cdot50$		
	289·		$2\cdot5\times2\cdot5=6\cdot25$		
	Deduct $\overline{9}^2=81\cdot$		$1\cdot\times2\cdot5=2\cdot50$		
	$4\times208\cdot$	= 832	107·125		
			Deduct $\overline{6}^2=36\cdot$		
			$4\times71\cdot125=$		284·5
	$3\times2=10$				
	$7\times5=35$				
3.	$11\times5=55$				
	$18\times10=180$				
	$24\times5=120$				
	$21\times36=756$				
	1156				
	Deduct $\overline{18}^2=324$				
	832	= 832	Embankment =		0
		6)1664			6)569
	Mean area =	$277\frac{1}{3}$		Mean area =	94·83

Mean area,	$277\frac{1}{2} \times 30 = 308{\cdot}1$	Mean area,	$94{\cdot}83 \times 30 = 105{\cdot}4$
By rule No. 1,	$= 462{\cdot}2$	By rule No. 1,	$= 158{\cdot}$
By rule No. 2,	$= 308{\cdot}1$	By rule No. 2,	$= 105{\cdot}4$

Objections may possibly be urged against the hypothetical generation of intermediate ground by means of middle sections, and it is difficult to free this subject wholly from exception; but with a given number of transverse sections taken in the field, if close attention is paid to the inclination of the ground as developed by the end sections, and occasionally where it is very complex, if the figures are simplified by introducing additive or deductive solids, we have not yet met with any other practical method, giving results equally satisfactory.

Various expedients are known to engineers for facilitating the computation of the areas of cross sections, to attempt an account of which, though it might be interesting to students, would prolong this paper to an inconvenient length.

The above examples embrace, as we have stated, specimens of the principal varieties of excavation and embankment; and a little attention to the calculations and the modes of deducing the middle sections between those usually taken in the field, will enable any one to apply the "Prismoidal Process" to the mensuration of earth work upon canals, roads or railroads. When the mean areas are computed, it will be much more expeditious to get out the cubic yards from the table of cubic yards previously made out (supposing the stations regularly 100 feet,) for each foot and tenth of mean area, from 0·1 up to the largest which commonly occur: such or similar tables in manuscript are in the possession of many engineers, but those who have them not can in a few days construct a set by simple addition, and verify them by observing how the cubic yards for the preliminary areas of the first hundred, are subsequently repeated in the same decimal place.

Indeed, Mr. Macneill's tables (if extended to tenths of feet) might be used; by constructing a supplemental set to show by inspection the height or centre cutting in level ground, of two sections with the given base and slopes, to be respectively equivalent in area, to the end sections of any given length of excavation or embankment; or these heights could be ascertained by the aid of an ingenious formula given by Mr. Macneill, and being found might then be wrought with in entering the tables according to the directions laid down: either of these proceedings, by determining a true mean cutting at each end, would obviate the necessity of a middle section, but neither, it is believed, would be altogether as satisfactory.

We desire to be understood as suggesting the application of the preceding process only to those exact calculations, required by the *final estimates* of sections; for running estimates or those on lines of location, less accurate but more speedy methods will answer every purpose.

Oldtown, Md., November 20th, 1839.

CHESAPEAKE AND OHIO CANAL.

This stupendous undertaking has made little progress for some years, as our readers generally know. In the last report the company "only ask the State to waive these unproductive liens to such an amount as may be necessary to finish the work to a profitable terminus, on its own resources. We do not think it possible that this application will again be refused by the legislature. It cannot be rejected, unless the people of Maryland have made up their minds to throw overborad their heavy investment in the Ches-

apeake and Ohio canal without an effort to save it, and fasten upon themselves and their posterity a permanent system of direct taxation."

One of the main objects of the report is to show that the interests of the company demand the continuation of the canal to the mines, and that they should not stop their works at dam No. 6, and depend on the railway as a feeder. This is sound reasoning and we sometime since attributed the success of the Delaware and Hudson canal company, to the circumstance of their owning all *from the mines to tide water.* It appears that only 18 miles are required to complete the canal to Cumberland when a large business is certain. The amount estimated as sufficient to finish the canal to that point is $1,500,000, and the company appear to be sanguine as to the practicability of raising this sum. The total cost of the canal thus far exceeds $12,000,000 and before even 5 per cent. can be paid on that sum, an immense business must be done.

The very low rates at which the Baltimore and Ohio railroad company offered, last winter, to carry coal has greatly alarmed them, and they appear disposed to deny the accuracy of the calculations of the company. They even publish a correspondence with a young English engineer travelling in this country who positively asserts, that the company "cannot carry coal and iron (except at a loss) for one and one-third cents per ton per mile; and experience has taught us in England that railroads cannot compete with canals in the carriage of heavy goods." A short article from Herapath's Railway Magazine in this number, will perhaps answer the latter position. With respect to the cost, the weight of authority is immensely in favor of the railway; but we are spared the necessity of discussing this point as we fully agree with the canal company in the importance of carrying their canal as near the mines as practicable. We also consider canals in that comparatively mild latitude far more efficient works than in New York and northern Pennsylvania where they are, with very few exceptions, incomparably inferior to *well located* common roads, a species of communication almost unknown in this country of rivers, lakes, railways and canals.

We see no allusion to the company working their own mines. To this circumstance we attribute the success of the Delaware and Hudson canal company. The coal in the cars costs them about 40 cents per ton—the mere labor of mining—and the difference between that sum and the price at which the coal is sold—$3,50 per ton—goes to pay the cost of transportation and dividends. If the Chesapeake company cannot adopt this plan, and secure to themselves the additional value which they confer by conveying the coal to market, we see little prospect of that undertaking ever becoming successful; and, unless we are much mistaken, they have more to expect from this course—working their own mines—than from any other plan they can adopt. Notwithstanding the low price of coal, we understand that at least one new route to the anthracite region is in agitation, with

what success we know not. But if the Delaware and Hudson company divide ten per cent. while the Lehigh and Schuylkill are totally unproductive, might not a work similar in its operations to the first prove a good investment?

BALTIMORE AND OHIO RAILROAD.

We recently observed in a Cincinnati paper, a statement that B. H. Latrobe Esq., chief engineer of the Baltimore and Ohio railroad, was then in Ohio making a reconnoisance for the route of a railroad from the Ohio river to Cincinnati, to be a continuation of the Baltimore and Ohio railroad. The importance of the early completion of the railroad to the Ohio is becoming more and more evident every day to all who give the subject a thought, and it is truly surprising that a work of such vital importance as well in a national as a local point of view, should be thus delayed for want of the necessary legislation.

The enterprize and energy of the citizens of Baltimore stand out conspicuous in the magnitude of her public works. They were among the *earliest* in this country to engage in the construction of railroads, yet they hesitated not to embark more largely in them than any other city in the Union at that period; and of course, as with those who commence most new enterprizes, they have paid somewhat dearly for their experience, yet they have overcome the main difficulties. The *mountains* before them, with their present experience are as nothing in comparison with what they have overcome in their early want of knowledge of what could be accomplished with locomotive engines, in the prejudices of the community and in a powerful competitor for the right of way. Let them therefore press upon the legislatures of Maryland and Virginia the importance--the *necessity*—indeed, of early and liberal legislation which shall insure the completion of the road to the Ohio at the earliest period possible.

The net revenue last year, when, as now, only about half completed and terminating in a small village near the mountains, was nearly $300,000, and this year it will be very nearly if it does not exceed $400,000. An income which will enable them if the shareholders will forego their dividends for a few years, to raise the necessary funds to complete the work; and thus secure to Baltimore *the* great thoroughfare for *travel*, and an immense amount of transportation between the Atlantic seaboard and the valley of the Ohio and Mississippi thereby giving her the relative position occupied by her previous to the completion of the canals of New York and public works of Pennsylvania. Even now when nearly one half the distance between Baltimore and the Ohio is performed, the travel in stages, and the transportation in wagons, it is immense. The long line of post coaches, with their sleek horses and merry drivers, drawn up before the hotels when the cars arrive at Cumberland, reminds one forcibly of old times on the route between Albany and Buffalo. The huge mail bags and ponderous trunks are piled on and the passengers stowed away eight or nine inside

and often one with the driver, when crack goes the whip and away goes No. one, two, three and so on until they number seven, eight or nine and often, indeed, ten or twelve in a string, bound for the Ohio, at Wheeling or Pittsburg—the distance being about 130 miles and is performed in about 24 hours steady driving—whereas the distance from baltimore to Cumberland 178 miles, is performed in less than ten and may be done in *eight*, hours in the comfortable cars of the railroad company, with very little fatigue. Notwithstanding the amount of travel on this route, the enterprizing proprietors, Messrs. Falls and company, have, we were informed and should judge from what we saw, always a supply of good coaches, so that there is no delay at the termination of the railroad, as at Chambersburg on the Pennsylvania route, where passengers frequently have to lay over a day for a seat.

The passenger cars on this road are unusually spacious, and the seats are so constructed as to enable those who have been riding all night in the stage to rest and sleep if they desire, and also to prevent easy access to their coat pockets by those whose fingers are habitually that way inclined. Their connection is also both simple and safe. An iron rod, 1¼ inch diameter passes the whole length, under the bottom and through a plate of spring steel in the centre, which serves both as spring and buffer, to prevent unpleasant concussions at starting and stopping; these rods are then connected by a small bar of wood which is ample to sustain the direct pull of the train but very likely to break when the locomotive runs off the track and thus avoids carrying the cars off with it. We commend this mode of connection to other companies as well worthy their adoption.

Cast iron wheels, cast on a *chill* are used for their locomotives, in preference to wrought tyre. They are much cheaper and are spoken of as equally safe and less likely to slip on the rail. They also use the steel journal and chilled boxes in preference to the plain iron journal and composition boxes—by which there is a great economy of oil. As an evidence of the truth of this, we examined a car at Newcastle, on the Frenchtown road, having steel journals and chilled boxes which were filled with palm oil in the spring of 1843, and, though it has been used, we were informed, as much as any other freight car on the road, (zixteen miles in length,) yet there is still an ample supply of oil in the boxes to last the season, or until January next.

The travel over this road will, within five years from the time of its completion, give a gross income of over $1,000,000 per annum; and the freight and U. S. mail an equal or greater amount. Indeed it is difficult to fix a limit to the amount of business which will pass over it; connecting as it will at the shortest portage, the Atlantic and its vast seaboard and, indeed, *all Europe* on one side with the vallies of the Ohio and Mississippi and *Oregon* on the other.

Notwithstanding the great increase of business the present, over the past,

it will be still greater next year. The company now have a contract, operations under which are to commence by the 1st of November next, for over fifty thousand tons of freight from one concern annually. To accommodate this large increase of business they are now having made at the manufactory of Ross Winans, Esq., *six* locomotives of the heaviest class, and a large number of *iron* cars for coal. These engines are now nearly completed and will probably be in use most of them by the 1st of November; they are to weigh about 45,000 lbs. each and to have eight wheels of 33 inches diameter, all connected as propellers or drivers, and to be geered by spur and pinion wheels, so as to make about one and a half revolutions for each revolution of the main crank or shaft immediately operated upon by the steam power. This will give the engine a speed equal to four feet driving wheels without cog gearing; and enables the proper speed of the engine to be maintained without working the cylinders faster than is judicious, while driving wheels of very small diameter are used.

When engines have eight propelling wheels, with axles parallel to each other (as is the case with these) the safety and facility with which they will pass curves and through turn-outs, is materially increased by the use of small wheels. They resist, much more effectually, the increased tendency of the engine to run off the track occasioned by so large a number of axles in a parallel position to each other; yet this parallel position of the axles is necessary in order that all may be connected, in the most simple manner, to wit, by cranks and connecting rods from one to the other.

The cylinders are 17 inches diameter and 24 inch stroke and so arranged as to cut the steam off at half stroke and work the other half expansively, or to work full stroke, at the pleasure of the engine driver as the varying grade of the road or different loads require. They are also provided with a variable exhaust, that is, the exhaust pipe in the chimney may have its apperture contracted or extended at pleasure, thereby giving the conductor control over the steam-generating power of the engine, which can in no other way be so effectually had. By this means, together with the variable cut off, these engines are probably capable of exerting greater power than any other engines heretofore built either in this or any other country; they can also, at a moment's warning, do the work of the lightest class of engines with greater eeconomy even, than with those light ones now in general use. This is highly important on any road, but especially so on undulating roads where the duty of an engine is constantly changing from heavy to light and light to heavy, etc. The boilers will have about 1000 square feet of fire surface and 12 square feet of fire grate; to be arranged for the use of Cumberland coal. The tubes are of iron—welded by hand—2 inches in diameter, 8½ feet long and 212 in number."

The company are also constructing a large number of coal cars, on a plan which it is believed will effect a considerable saving in the cost of transportation. The body is of peculiar form, combining the strength of the

cylinder and the cone; resting on springs and placed on six wheels; weight designed to be 2½ tons and to carry 7 tons of coal, or at least ten per cent. more coal in proportion to the weight of cars, than those now in use on the road, which are believed to be equal to the best in use on other roads—weighing about 3½ tons and carrying 7 tons of coal. These cars are so constructed, being upon springs, as to avoid much of the heavy concussion to which such heavy loads are liable, on a railroad at the usual speed; and they are also constructed with a special view to adjusting themselves to the curves on the road, by means of steel bearings or springs, placed edgewise, the ends made fast to the frame and the centre to the box which receives the journal of the axle and thus the three axles are allowed to conform to the curve and then to return to their position on a straight line, or to conform to a reverse curve.

Railways and Canals.—In the appendix to a statement issued on behalf of the Grand canal company of Ireland, in the matter of the proposed railway to Cashel, there are given some curious details as to the effect of railways on canal property. Thus, the Grand Junction canal, which forms the first 90 miles of water communication between London and Birmingham, had, in the three years immediately preceding the opening of the railway, an annual revenue from tolls, ranging from £174,722 to £198,000, regularly increasing. Since the railway has been fully in operation, this revenue has varied from £121,139 to £113,012. The Rochdale canal is 33 miles long, and throughout the entire distance the Manchester and Leeds railway runs parallel to it. In the three years previous to the opening of the dailway the tolls renged from £62,059, to £59,258; in the last three years they have varied from £31,533 to £27,165. The Kennet and Avon canal, and the Wilts and Berks canal, are both affected by the Great Western railroad, and the tolls of the former have fallen since the railway was opened from £46,703 to £32,045, and of the latter, from £19,328, to £8,477. The Fourth and Clyde Navigation has gone down from £62,516 to £42,218; and the Union canal, which connects Edinburgh with the Fourth and Clyde canal has had its net profits reduced by railways from £12,000 to £4,284. The market price of canal stock, has, of course, suffered in proportion. Thus, shares in the Grand Junction canal have fallen from £330 to £148 per share; Warwick and Birmingham, from £330 to £180: Worcester and Birmingham, from £84 to £55; Kennet and Avon, from £25 to £9; and Rochdale, from £150 to £61½; while Coventry canal shares, which at one time were as high as £1,200 per share, have fallen as low as £315.—*Herapath's Journal.*

ENGINEERING EXTRAORDINARY.

In accordance with our promise we submit to our readers a specimen of what we have ventured to call extraordinary engineering. We should have alluded to this matter long since had we sooner received a copy of the evidence, of which the principal extract given in this article is a very favorable specimen.

It appears that a parliamentary committee was appointed to examine the accuracy of the statements of the chairman of the board of works of Canada, who asserted that a canal round the "Cedars" rapids on the north side

would cost above £100,000 more than a canal on the south side of the St. Lawrence. The only engineer giving evidence against the board—Mr. Casey—said that, the lockage being the same on both sides and the incidental works not materially different and not very important on either side, the difference must be sought for in the earthwork. But the total cost of this by his estimate little exceeded £100,000 and at the prices of the board of works actually fell short of that sum. On seeing the estimates of the board he pointed out how they made out their case. We give one of his objections and an extract from Mr. Killaly's answer or defence, which, though not *exactly* a refutation of Mr. Casey's charge, is quite as much so as any other part of his paper.

"In looking over the estimates just submitted by the board of works, in order to answer a comprehensive question put to me some days before those documents were received, I perceive that the line on the north side, on which the board base their estimates, by which they are enabled to show a difference of £100,000 against that side, and by which a reluctant assent to the location of the canal on the south side has been wrung from the right honorable the secretary for the Colonies, is far, very far, inferior to *another* line connecting the same points, and *well known* to the board of works.

"By the 'inland route,' surveyed by directions of the commissioners, in 1833, for a canal 100 feet bottom, by 10 deep, one-sixth larger than the present canal, there are—

Excavation,	cubic yards,	2798913
Embankment,	"	310139
		3099052
Less one-sixth,	"	516508
Total quantity by route of 1833,		2582544

By the route of the board of works, there are—

Excavation,	cubic yards,	3076000
Embankment,	"	289066
Total quantity by route of 1842,		3365066
" " " 1833,		2582544
Difference in favor of route of 1833,	cubic yards,	782522

N. B. See "note" to document 22.)

This, at one shilling per yard, would amount to nearly £40,000; but I pass this by at present.

"The entire investigation rests, and *necessarily* so, on the assumption, that the board have, in their comparison, brought forward the *best* line on *each* side; for there is no more justice in charging one line with difficulties, which it is known can be avoided, than in giving another line credit for facilities of which it is known it cannot avail itself. You will please observe that I refer exclusively to surveys made by government, in 1833 and 1842, the former of which are confirmed by my examinations of this year. The difference is sufficiently remarkable, both as to amount and direction, and I beg leave respectfully, but earnestly, to call your immediate attention to it."

Mr. Killaly says:

"Before looking at those voluminous documents, I had expected to find in them, at least, some testimony bearing upon the question at issue, worthy of my most serious attention; but a very cursory examination of it has been snfficient to convince me that the evidence itself is of a character to

preclude me or any other professional engineer, from attempting to analyse it, with a view to useful results. That portion of it, adduced in support of Mr. Simpson's charges, consists, for the most part, of matter which I may term a sort of ignorant gossip, almost wholly irrelevant to the subject. It is not indeed, wanting, in bold assertions of opinion; but those are made in language which is alone sufficient to prove to a man of experience that the witnesses by whom they have been made are profoundly ignorant of the very nature of the question, with respect to which they speak so confidently: The evidence is curiously characterized by vagueness, self-contradiction, confusion of ideas, gross exaggeration and positive misstatements.

There is but one point in which the witnesses are constant and consistent with themselves, and with each other—they all display, in a manner that must be obvious to any observer, a keen anxiety to establish Mr. Simpson's charges, by means of reckless assertion. I think I may safely add, judging from internal evidence alone, that the testimony of the witnesses has been concocted among themselves, or that their minds have been under the guidance—not to say direction—of some one or more persons, whose business it has been to get up a case in support of Mr. Simpson's accusation against me. These witnesses would have seem to have been, as it were, well drilled for the occasion. From this description I do not except either the written or verbal testimony of Mr. Casey, the engineer, employed by Messrs. Simpson and Harwood, and brought forward by Mr. Simpson as a witness against me. This gentleman himself states, (I use his own words,) "the object of my examinations and report was not to furnish an estimate "of the probable cost of a canal on the north side, but merely to show that "the Hon. H. H. Killaly was wrong, in leading the public to believe that "a canal on the north side would cost £100,000 more than the south side;" and accordingly up to this very day, he had not made any estimate in full of the cost of constructing a canal on the north side: on the south side he states he has not been for seven years; and, in answer to a question, he says that when he came before the committee he was not aware of so important a point as the scale upon which the present canal is being constructed. These two statements are characteristic, in all respects, of the whole of his testimony, namely—the absence of any valuable or even available information, with respect to the particular subject which he pretends to examine. He might well say that his only object was to criticise a report of mine; for the greater part of his entire testimony consists of a sort of literary strictures on my report to the governor-general, of the 1st of August last, and is far more fit to form articles in a newspaper opposed to the government, than to be submitted to a committee of the legislature, with a view of guiding their judgment upon a scientific point. I am sure that, in my long professional career, I never met with anything, purporting to be the production of an engineer, which so clearly evinces a determination, *fas aut nefas*, to make out and bolster up a case for the employers, and so utterly undeserving of serious notice."

Mr. Simpson's main charge is that "vessels which the canal would be capable of bearing, will be incapable of getting in and out." (Ev. p. 59.) Mr. Killaly says (p. 60,) there are "three entrances of from 600 to 1200 feet in width each and with a depth of water averaging from 12 to 20 feet." Now the pilots and numerous other persons in the neighborhood and two members of parliament, Messrs. Chesley and McLean, testified that in place of *channels* there were *shoals* with 3½ to 8½ feet in the *deepest* places! Mr

Casey says "*no trace of a single such channel can be found.*" This objection is answered as follows:

"The other witnesses brought forward by Mr. Simpson, although they do not pretend to science, like Mr. Casey, are disqualified, by their utter ignorance of the subject, from offering any opinion to which I can pay respect. They consist of pilots, wharfingers, farmers, a stage-coach proprietor, a store-keeper, a doctor, a timber merchant, residing at Bytown and the agent of an insurance company; the latter being Mr. Simpson's step-son; and the whole of them, not excepting the merchant, at Bytown, are deeply interested persons."

We fully agree that Mr. C.'s scientific pretensions do not enable him to turn 3½ into 12 feet of water, though we still consider pilots, wharfingers and even members of parliament capable of sounding water 4 to 8 feet deep. Yet after all this, Mr. Killaly says there are "two channels with *not less* than 8½ feet water," while Mr. Chesley says (p. 12) "I found in not less than 40 places a depth not exceeding 3½ feet." This is one of those misstatements—we use exceedingly mild terms—which admit of but one explanation.

Mr. Killaly's only argument is, that those daring to differ from him may have some direct or indirect interest in the question at issue; and, having shown or asserted this, he considers their evidence *proved* unworthy of credence. The extent to which he believes in this ennobling principle is boundless and openly avowed; it would be merely ridiculous and contemptible but for the vast power vested in his hands which he has exercised in constructing works of the most absurd dimensions. The difference in his defence and that of Mr. Brunel or of Mr. Samuda is distressing, and powerfully illustrates our remarks in a late number on the importance of *character* to the engineer who aims at anything higher than his salary. How different would have been the state of the public works and of the finances of the Province, had the services of a professional man been obtained with the skill and charecter of an engineer and a gentleman! Even a flying visit from Mr. Brunel, Mr. Rennie, Mr. Vignolles, Mr. Stephenson or any other experienced British engineer might have saved Canada from spending immense sums on works which are not merely worse than useless themselves, but which act so powerfully in preventing the undertaking of works really needed by the country, and which would again by their success lead to the rapid extension of similar communications wherever the wants of the community were such as to justify the necessary outlay. A case in point has just occurred. Suppose that, instead of building a canal to rival the St. Lawrence—see the fable of the frog and the ox—a railway had been carried to the lines about 80 miles at half the cost of 12 miles of ship canal along a navigable river. Then the Province would have saved $800,000 direct, a considerable annual sum in repairs, would have possessed a work at least supporting itself from the beginning and which would soon have paid 4 per cent. on its small cost. Then we should not have seen the late important railroad convention at Boston take place *without an allusion to a*

communication with Montreal via the Connecticut and Passumpsic rivers. The object *then* would have been to carry the line as for north as possible, *now* they propose striking the south-east corner of Vermont. So that by utterly neglecting the cheap railway for the extravagant ship canal, the immediate benefits of the former are all lost to the present generation and its actual completion either delayed to a distant period, or it may be, altogether prevented. Such is the inevitable result of placing the public works—the most important of all interests in a new country—in the hands of political adventurers as ignorant of, as they are indifferent to, the interests of the confiding people on whom they batten.

We also find that some months after the work had been commenced the board was ignorant of "the nature of the bottom" of the shoals to be excavated, (p. 23) and, to cap the climax, that the board had *never met!* (p. 12). There was therefore nothing to interfere with the little arrangements of Messrs. Killaly and *Wakefield* whether of an engineering or financial nature. We are informed that the latter is generally considered to be the author of the paper from which we have made extracts, and it is every way worthy of "*his* long professional career." Of the "career" in which the former has displayed *his* "great scientific acquirements," (p. 40) we shall one of these days be able to speak with equal confidence.

For the American Railroad Journal and Mechanics' Magazine.

READING RAILROAD FOR 1845.

The advantages under which this railway will operate in 1845, and which it has not in 1844, although it will have delivered in this last year 400,000 tons besides the travel and merchandize, may be enumerated as follows:

1st. Full connection with *all* the mining points in the Schuylkill region.

2d. Motive power improved by Baldwin's *jointed* locomotive to *treble* its former power, with *less* wear and tear to machine and road.

3d. A full complement of cars adequate to the delivery of one million of tons per annum.

4th. Ample wharf accommodation for venting two millions of tons per annum, if required.

5th. The toll on coal in place of $1 to 1,25 per ton, will be raised to $1,37 to 1,50 per ton.

6th. *A double track* of solid railway the whole length of the line, imparting to all these advantages despatch and regularity; and as their final and collective consequence, producing an economy never before realized on any other railway in the world, moving such a mass.

It is now certain that 8 to 900,000 tons of coal will descend the Schuylkill avenue in 1844, and with only a moderate increase, it may be expected that 1,000,000 of tons will descend it in 1845. Of this quantity the railway will have the carriage of at least 7 to 800,000 tons, to which it will be fully competent. The result for that year, on the above premises and assuming that the proprietors of this road will see the advantage of *exclusively*

and at once adopting Baldwin's improved motive power, would then be somewhat as follows. It is a case, which will be found an *exception* to the prudent rule of stopping to count the cost.

Coal, 800,000 tons (equal to 2700 tons per day for 300 days) at an average of $1,40 per ton,		$1,120,000
Travel and merchandize, $15,000 average per month,		180,000
		1,300,000
EXPENSES.		
Transporting coal at 25 cts. per ton,	200,000	
do. travel and merchandize at 25 per cent.	45,000	
Maintenance of way at $700 per mile of double track,	70,000	
General charges,	65,000—	380,000
		$920,000
Interest on $6,500,000 of loan at 6 per cent.	390,000	
do. 1,000,000 do. 5 per cent.	50,000—	440,000
Capital, 2,000,000 (equal to 24 per cent. for contingencies and dividend,)		$480,000
$9,500,000		

In explanation of what is meant by Baldwin's improved motive power, subjoined is an estimate of its cost per ton, compared with that of the old mode of transportation as collected for *this road.*

Items of expense.	Common 8 wheel 12 ton engine. Wooden cars.	Amount.	Jointed 6 wheel 16 1-2 ton engine. Iron cars.	Amount.
Engine drivers pay,	2 days, $2 per day,	$4,	same	4,
Fireman's do.	2 " 1,25 "	2,50	do. 2	5,
Conductors do.	2 " 1,30 "	2,60	do.	2,60
Brakeman's do.	6 95 "	5,70	do. 8	8,
Fuel,	wood and coal mixed	18,	do.	22,
Oil for engines,	2 galls. 86 cts.	1,72	do. 2 1-2	2,12
Repairs engine & tender,	180 ms. pr trip 6 cts.	10,80	do. 5 cts.	9,
Repairs cars,	185 ts., w'd c'rs 9 cts.	16,65	500 tons, iron cars 5 cts.	25,
Oil and grease for cars,	do. 1 1-4 cts.	2,31	do. 12 1-2 cts.	7,50
Supplying water,		50		85
Renewals of sundries,		1,72		4,28
Prop'n of assist. engine at 1 mile 42 feet grade,		2,50		2,65
Cost of a trip of 2 days or of 180 miles,		$69		$93,
Gross load of train,	340		775	
Number of cars hauled,	56 of 1 1-3 tons each,		100 of 5 tons each.	
Net weight of coal,	185		500	
Making a cost per ton of,	37·30 cts.		18·60 cts.	

The improved jointed Baldwin engine of **16½** tons is guaranteed by the builders to haul **500** tons at a trip as its regular load and to that it will ultimately be appointed. These engines could thus be made to deliver *one million* of tons running *three hundred and sixty thousand* miles, while with the old ones, it would require *ten hundred thousand* miles, that is, in the one case barely *one* ton is carried to the mile run, while in the other, it is nearly *three* tons. The above comparative table of items shows that, on this new system of transportation, that **25** *cents per ton for motive power and wagons* is a full charge for the road.

It is not long since that ridicule was the sure portion of him who asserted that the freight of coal on this road would not cost over **55** cts. per ton, while now, thanks in good part to Messrs. Baldwin and Whitney, it has been reduced down, to from **20** to **25** cts. per ton. It is gratifying to know that this valuable invention is properly appreciated, and that they now have

their hands full in the manufacture of these admirable machines, from 8 tons up to 20 tons, for many of the railroads in the United States. Their workshop now gives employment to 350 hands.

The character, capacity and general appointments of this railway are therefore such, that if it ultimately costs ten millions of dollars it will be a cheap machine at that rate; and if from the untoward circumstances of the times through which it has been completed, this cost has been largely but unavoidably swelled, the expense of working it, has been more than proportionally cheapened, as compared with the original estimates.

Philadelphia, Sept. 1844. F.

RAILROAD CONVENTION.

A convention of citizens from Vermont, New Hampshire and Massachusetts was held in Boston, at the Tremont Temple, on Friday the 20th of September, for the purpose of calling the attention of the citizens of *Boston* to the continuation of the *Fitchburgh* railroad to Connecticut river, and thence to Burlington, Vt. There were many delegates present, representing the whole line to Burlington; and for a part of the way *several* routes were represented. *Abbot Lawrence*, Esq., of Boston, was called to preside, and on taking the chair, he made an address very appropriate to the occasion, which occupied but a short time in its delivery—as he said time was precious—and was to the point. He spoke of the advantages which Boston had derived from railroads, and of the importance to Boston of extending the system where it can be done, and especially into Vermont and to Burlington, that there may be a direct, easy and rapid communication with the capital of Canada. He said that on reading the report which had been put into his hands, he came to the conclusion that it was his *duty* as a citizen of Boston to subscribe $10,000, that he owed it to the people of Boston and therefore he decided to take that amount of stock; but on reading the letters of the Hon. Charles Hudson, in relation to the advantages of the road, a gentleman in whom he had the utmost confidence, he had come to the conclusion to subscribe $20,000 *more* as an *investment*, and he was ready to do it.—When a little sectional feeling seemed to show itself in the discussion, he urged the gentlemen to avoid anything which might defeat or defer the object of the meeting, as he thought the present was *the* time to press forward this work, so important to Boston. A committee of fifty gentlemen were appointed to take the matter in hand and obtain subscriptions to the stock, which will undoubtedly be done, notwithstanding there has been over $1,250,000 of railroad stock already subscribed in Boston since January, 1844. Had New York but a few men like ABBOT LAWRENCE to *lead*, we should soon have a railroad to Albany and another to *lake Erie*.

AMERICAN RAILROAD IRON.

We recently visited the Mount Savage iron works near Cumberland in Maryland, mainly for the purpose of ascertaining what progress they had made in the manufacture of railroad iron. We found the work fairly commenced, a large quantity made and they were then about to commence working

a double set of hands—that is to say, day and night. The rails then on hand, which are of the "bridge" form, 48 lbs. per yard, or a part of them, were to be laid on their own road, to connect with the Baltimore and Ohio road at Cumberland, about ten miles, which will thus open the way to send the bitumenous coal to market at a cheaper rate than it has hitherto been afforded at.

The works of this company now in operation, and nearly ready for use, appear, to one unused to such operations on a large scale, quite extensive; yet we were informed that only a small part of the contemplated works are built. Two large smelting furnaces are completed, one was then, and the other would be in a few days, in blast. A large rolling mill with eight or nine puddling furnaces in full operation and with which they were making railroad and other iron at a rapid rate. There was also nearly completed a large building for nail works and another for a cupola furnace. Dwellings for about 500 laborers, and a large storehouse completed and in use, constitute the present establishment, forming quite a village in the midst of the forest and surrounding hills which rise several hundred feet above the lofty chimneys in every direction.

The position for the works is admirably chosen, at the base of the hill, where it is so steep that a short bridge serves to connect the mouth of the furnace with the building in which the ore is prepared; and still the descent from the ore bed is so great that they are brought down to the furnace mainly by gravity.

The quality of the coal of this region is admitted to be at least equal, and by *many* deemed superior, to any other bituminous coal used in this country; and the iron ore found in its immediate vicinity is considered by good judges of superior quality—and the supply of both is believed to be inexhaustible—therefore we are induced to believe that at no distant day, the "Mount Savage Iron Works," will become celebrated, as well for the quality as the quantity of it iron—and especially for it railroad iron—and that, with other establishments, especially in Pennsylvania, which are now preparing to engage in the manufacture of railroad iron, we shall be able in the course of a year or two at farthest to make all the iron—and it will not be a small quantity—which we shall require in this country.

We shall refer again to these works in our next number and to the subject of the manufacture of railroad iron in this country—a subject in relation to which much will probably be said and written within the next twelve months.

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